The Multimission Operations Concept at the German Space Operations Center

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Multimission at GSOC - Overview

- DLR and GSOC
- Missions in Multimission
- 24 hour Operations Team
- Multimission Control Room
- Multimission Software
- Restrictions and Summary

DLR is Germany‘s aerospace research center and space agency.

Sites and Staff

5100 employees in 27 research institutes and scientific/technical Facilities at:

- 8 sites
- 7 field offices (only 2 shown here)

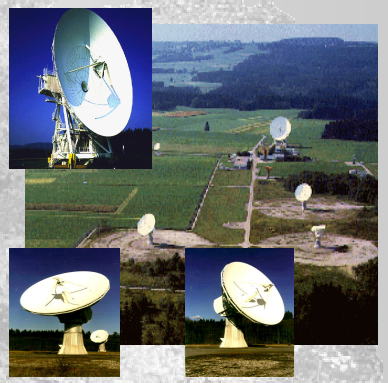
Offices in Brussels, Paris and Washington.

German Space Operations Center

German Space Operations Center (GSOC)

Control Center @ Oberpfaffenhofen

- Earth Observation
- Communication
- Navigation
- Human Spaceflight
- Design & Operation of Communication Infrastructure
- Research & Development of New Technologies



Ground Station @ Weilheim

Oberpfaffenhofen
Control Center

Weilheim
Ground Station

German Space Operations Center (GSOC)

Manned Missions

1983 Spacelab-1
1985 Spacelab D1
1992 Mir 92
1993 Spacelab D2
1994 X-SAR 1
1995 Euromir 95
1996 MOMS / Priroda
1997 MIR 97
2000 X-SAR / SRTM
2005 ISS Eneide
2006 ISS Astrolab

2007 ISS ATV-1
2007 ISS Columbus

* launch dates

black: mission completed
red: in operation
blue: in preparation

Scientific & EO Missions

1969 AZUR
1972 AEROS-A
1974 AEROS-B
1974 Helios 1
1976 Helios 2
1984 AMPTE
1986 IRS 1A
1988 IRS 1B
1989 Galileo
1990 ROSAT
1995 EXPRESS
1996 MARS 96
1997 Equator-S
1999 ABRIXAS

2000 CHAMP
2001 BIRD
2002 GRACE
2006 SAR-Lupe 1

2007 TerraSAR-X
2007..8 SAR-Lupe 2-5
2009 TanDEM-X
2011 EnMAP

Comm. & Navigation Missions

1974 Symphonie-A
1975 Symphonie-B
1987 TV-SAT 1
1989 TV-SAT 2
1989 DFS Kopernikus 1
1990 DFS Kopernikus 2
1990 EUTELSAT II-F1
1991 EUTELSAT II-F2
1991 EUTELSAT II-F3
1992 EUTELSAT II-F4
1992 DFS Kopernikus 3
1994 EUTELSAT II-F5
1995 EUTELSAT II-F6
1998 EUTELSAT W2
1999 EUTELSAT W3
2000 EUTELSAT W4
2001 EUTELSAT W1R
2002 EUTELSAT HB6
2002 EUTELSAT W5

2006… Galileo GSTB V2
2008… Galileo IOV
2010… Galileo FOC
2008... SATCOMBw

Multimission at GSOC
- Projects in Multimission

- BIRD
- CHAMP
- GRACE 1 & 2

- Next Projects planned for Multimission

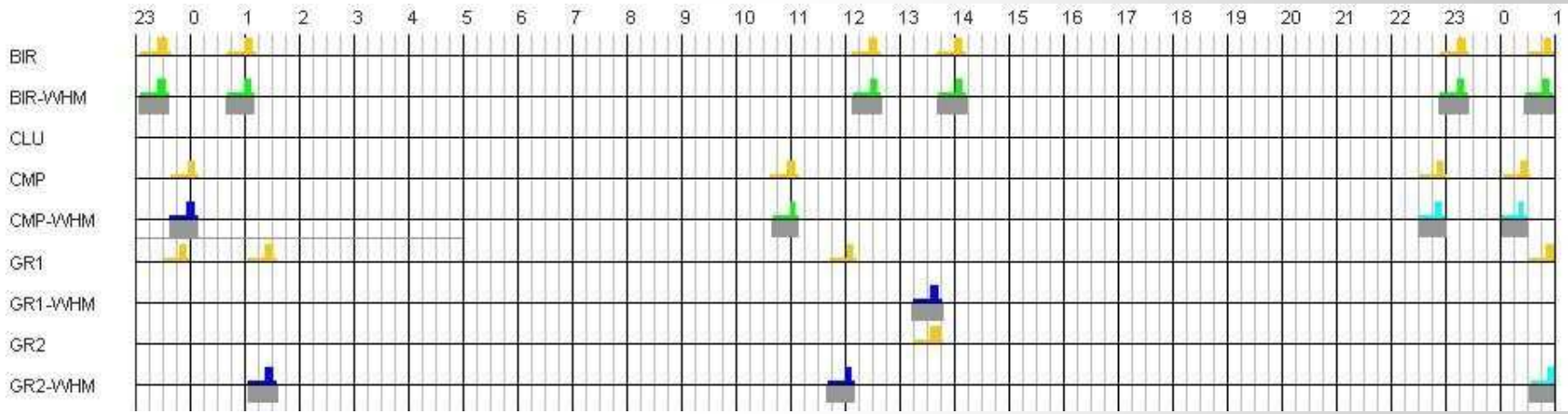
- TerraSAR-X (in 2007)
- TanDEM-X (in 2009)
- EnMAP (in 2011)
- TET (in 2009)

Multimission at GSOC
- 24 Hour Operations Team

- Staff is provided by contractors
- A 24 hour shift is established where one person is always available.
- This person is reinforced in times of higher activities (flexi-shift)
- All multimission-team members are trained on all spacecraft
- Team size is large enough to adapt the shift easily for holidays, sick-leave and fluctuations
- The team is performing operations autonomously
- They are supported by the spacecraft subsystem specialists

Multimission at GSOC
- 24 Hour Operations Team (continued)

- The same team also supports the command positions of projects in preparation and during LEOP
  - The experience and know-how from multimission operations is available to new project teams
  - The spacecraft knowledge is directly transferred into the multimission team



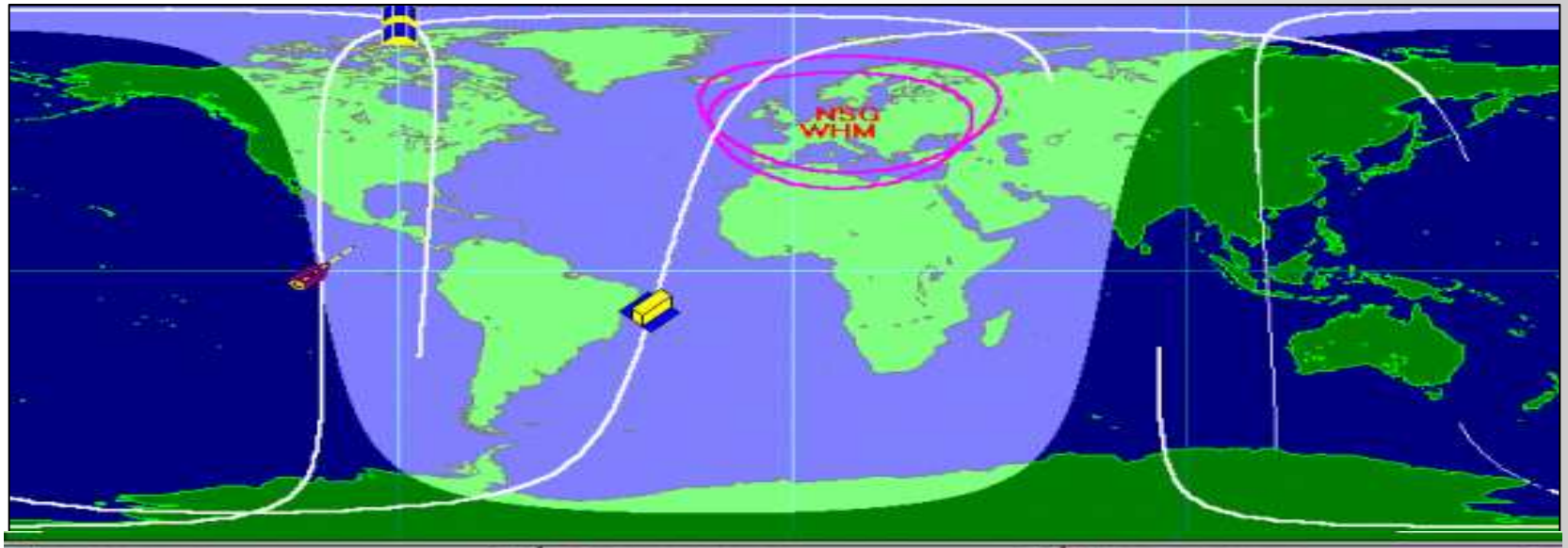
Multimission at GSOC
- Multimission Control Room

- All missions are flown from the same control room
- Each project has dedicated consoles to allow continuous work layout
- All computers are identical, as far as possible, to allow easier upgrade and moving of positions

Multimission at GSOC
- Multimission Control Room (continued)

- A typical workplace has three monitors on two computers
- One machine gives access to office applications, intranet and internet
- The other is connected to the operations LAN and can display telemetry as well as open the command system
- Operators may arrange machines individually

Multimission Operations
Earth Observation Missions



BIRD Orbital Parameters

Latitude	-13,5
Longitude	-32,2
Height (km)	542
Speed (km/s)	7,591
Lighting	Sunlight
Perigee (km)	521
Apogee (km)	558

BIRD

CHAMP Orbital Parameters

Latitude	1,9
Longitude	-107,6
Height (km)	396
Speed (km/s)	7,673
Lighting	Sunlight
Perigee (km)	386
Apogee (km)	399

CHAMP

GRACE Orbital Parameters

Latitude	84,7
Longitude	-88,9
Height (km)	470
Speed (km/s)	7,627
Lighting	Sunlight
Perigee (km)	464
Apogee (km)	498

GRACE

BIRD Passes

Stn.	AOS	Dur.	Time to
WHM	20:33:58	00:09:57	07:15:23
WHM	22:07:02	00:11:56	08:48:27
WHM	23:44:37	00:07:24	10:26:01
WHM	09:39:13	00:09:36	20:20:38
WHM	11:13:04	00:11:50	21:54:28

CHAMP Passes

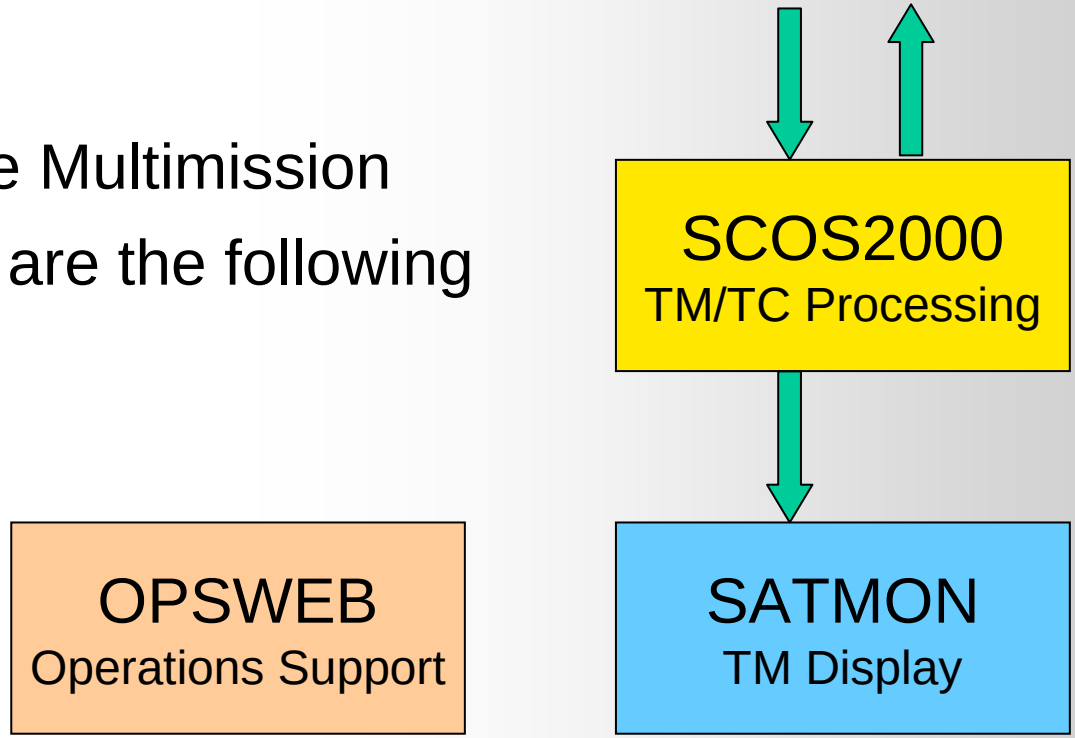
Stn.	AOS	Dur.	Time to
WHM	15:20:58	00:05:02	02:02:22
WHM	16:51:50	00:10:09	03:33:15
WHM	18:25:17	00:07:35	05:06:42
WHM	04:50:24	00:09:38	15:31:49
WHM	06:23:24	00:09:07	17:04:48

GRACE Passes

Stn.	AOS	Dur.	Time to
WHM	17:45:55	00:07:36	04:27:20
WHM	19:17:39	00:11:13	05:59:04
WHM	20:54:05	00:08:01	07:35:29
WHM	06:39:27	00:11:14	17:20:51
WHM	08:14:04	00:09:53	18:55:28

Multimission at GSOC
- Multimission Software

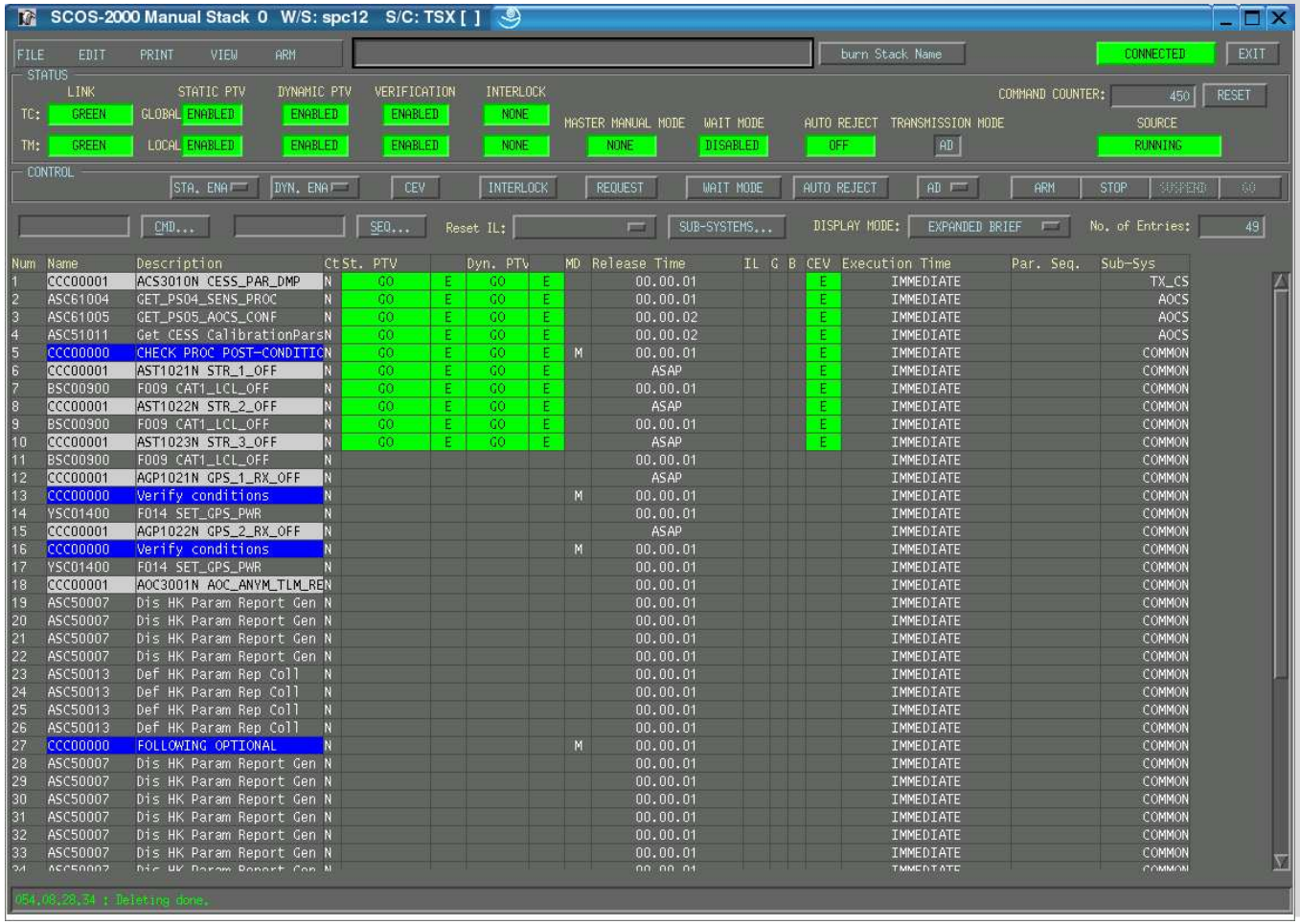
Central to the Multimission environment are the following applications:



Multimission at GSOC
- SCOS 2000

- SCOS 2000 is the GSOC Monitor & Control System of choice for new satellite projects
- SCOS-2000 was developed and is constantly upgraded by ESOC
- For the use at GSOC, SCOS is adapted and customized by contractors
- GSOC is currently using SCOS in version 3.1 for CHAMP and for TerraSAR-X
- The widely known and accepted standard of SCOS and its database format guarantee the availability of experts and problem resolutions.

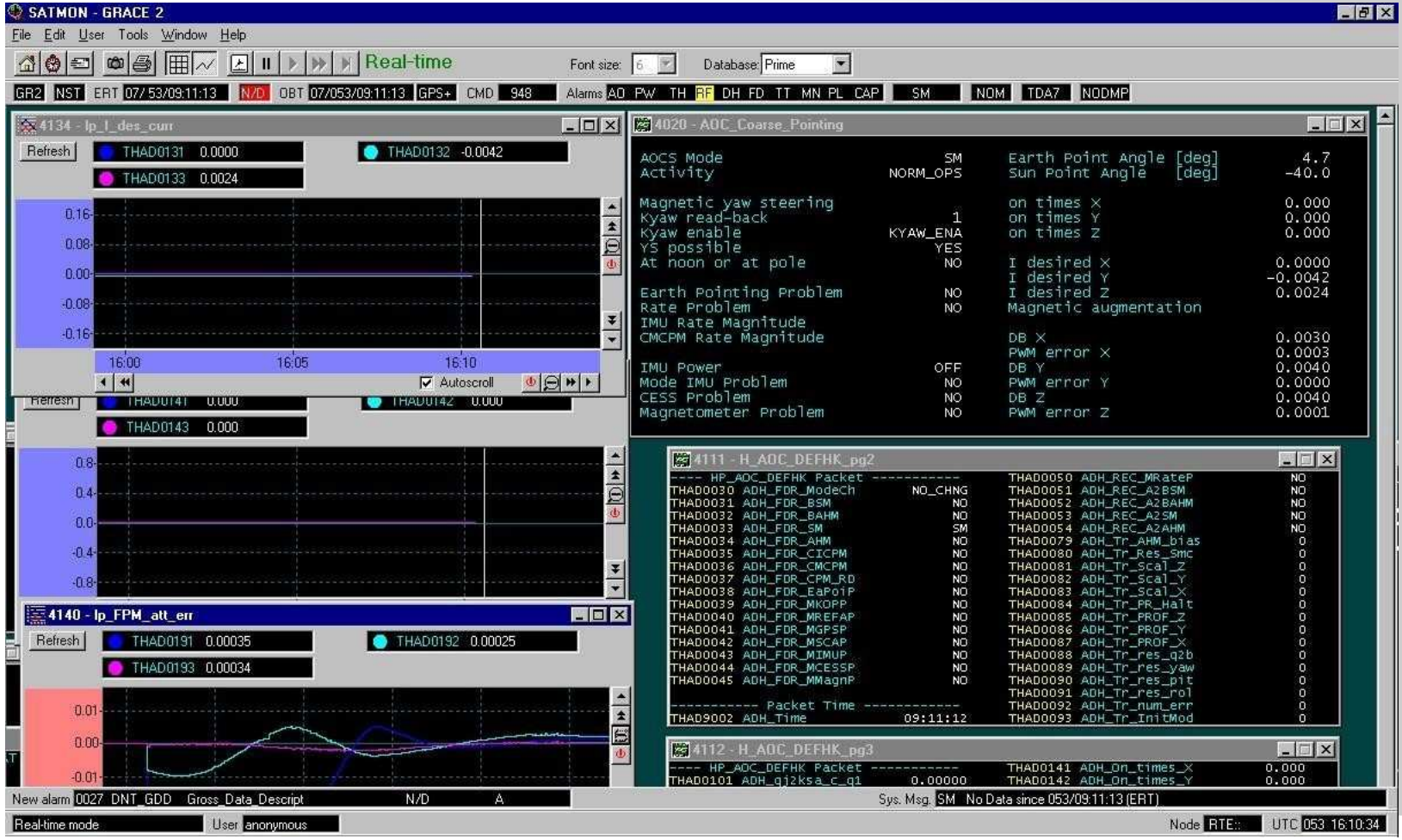
Multimission at GSOC
- SCOS 2000 (continued)



Multimission at GSOC
- SATMON

- SATMON is the GSOC telemetry display for all missions
- For all projects the same user interface is maintained although processing systems are different (SCOS, EPOCH, MCS, FRAMTEC)
- SATMON is developed by „Heavens-Above“ mainly for GSOC, but also for other customers
- Development is strongly influenced by the experiences gained in Multimission operations and several LEOPs

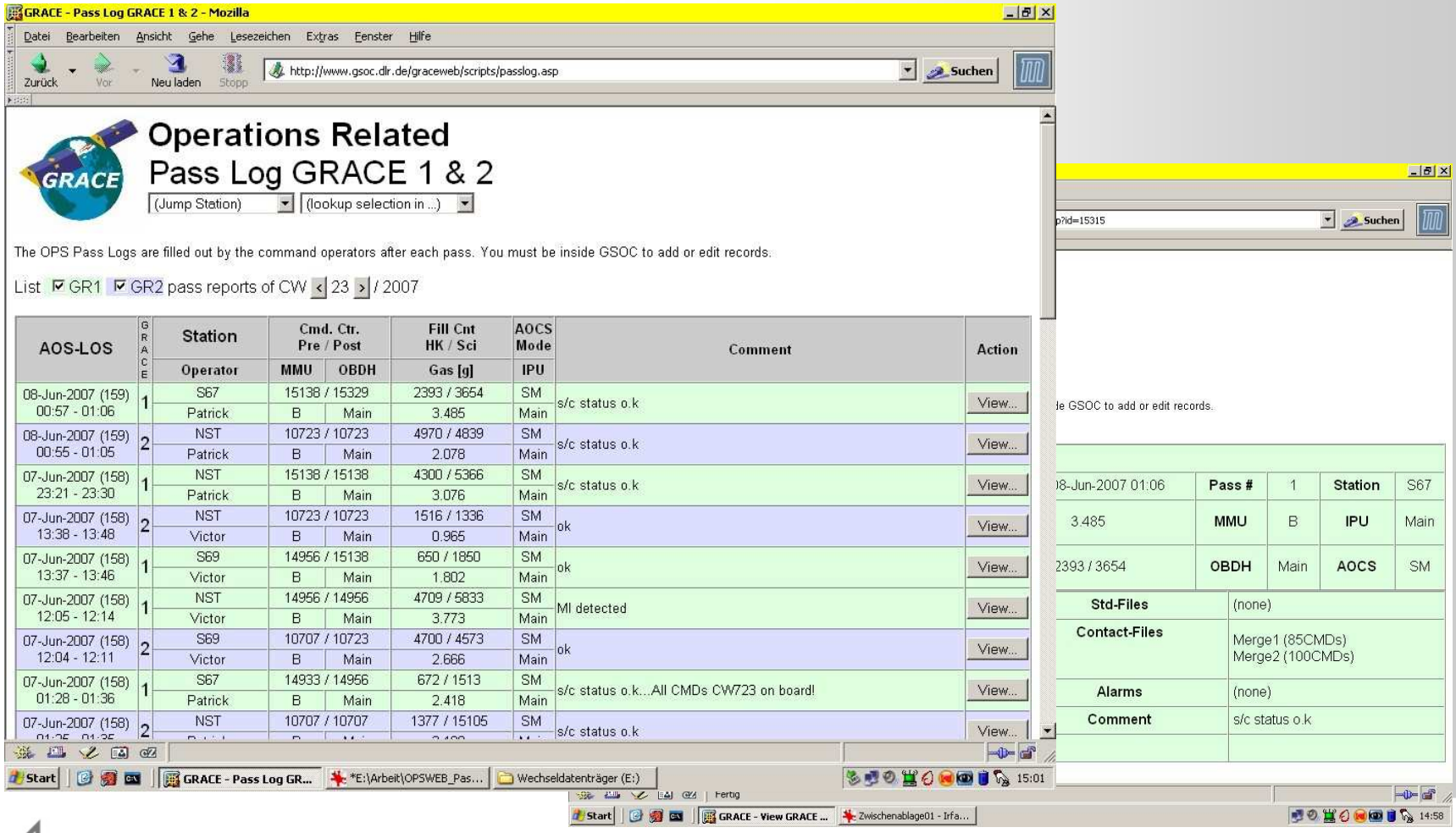
Multimission at GSOC
- SATMON (continued)



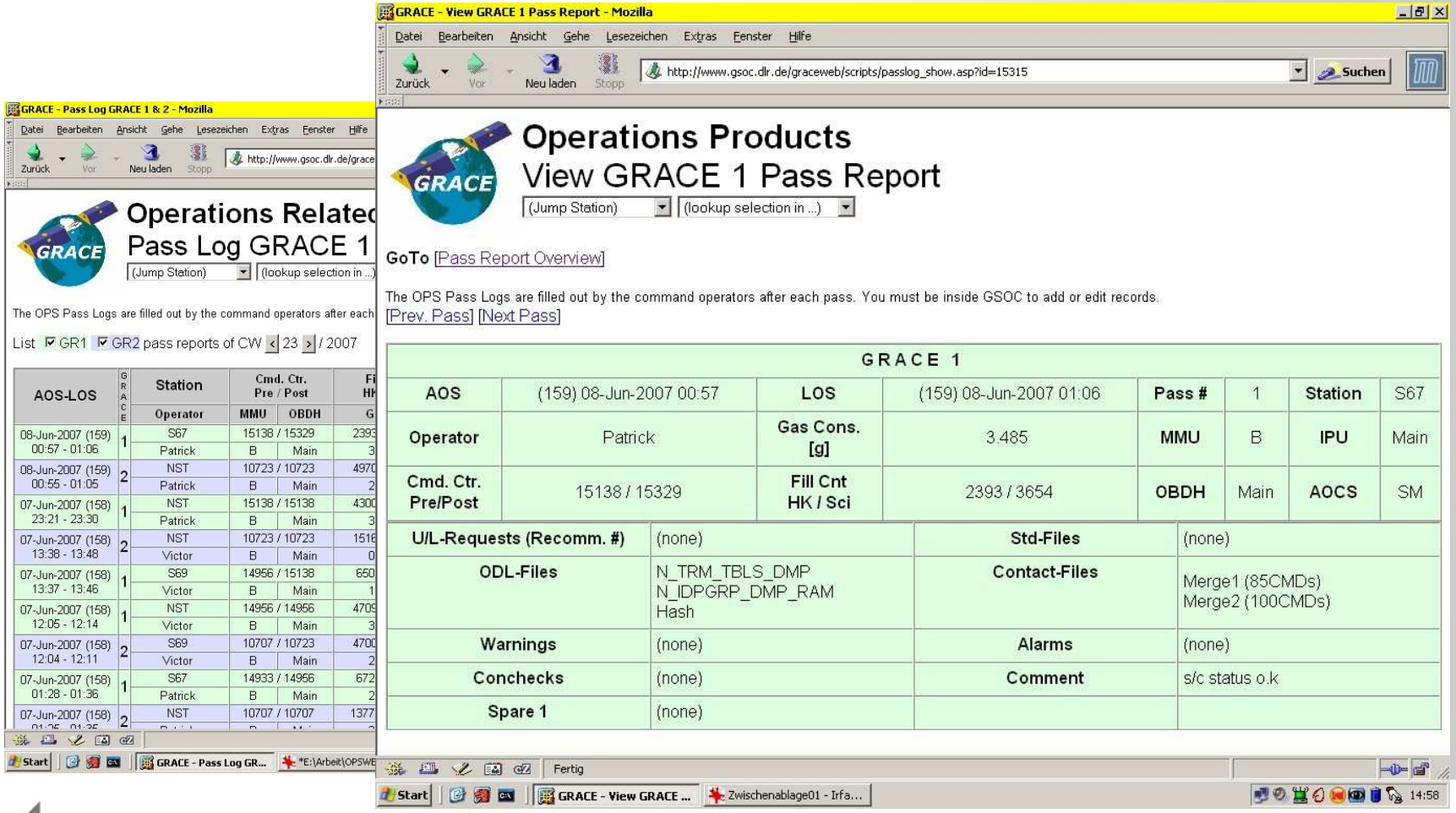
Multimission at GSOC
- OPSWEB

- OPSWEB is the GSOC intranet for satellite missions
- The OPSWEB is reachable from the control room, the offices and partially also from external locations
- It is the central location for data, tools and documentation
- For all projects a similar user interface is maintained although background data may be different (e.g. TM database viewer connects to SCOS, EPOCH and FRAMTEC; flight ops procedures may be MOIS or other format)
- Improvements triggered by new projects go directly into existing projects
- Multimission-Operators integrate and use their manuals via the OPSWEB
- Project logging is done directly in the OPSWEB

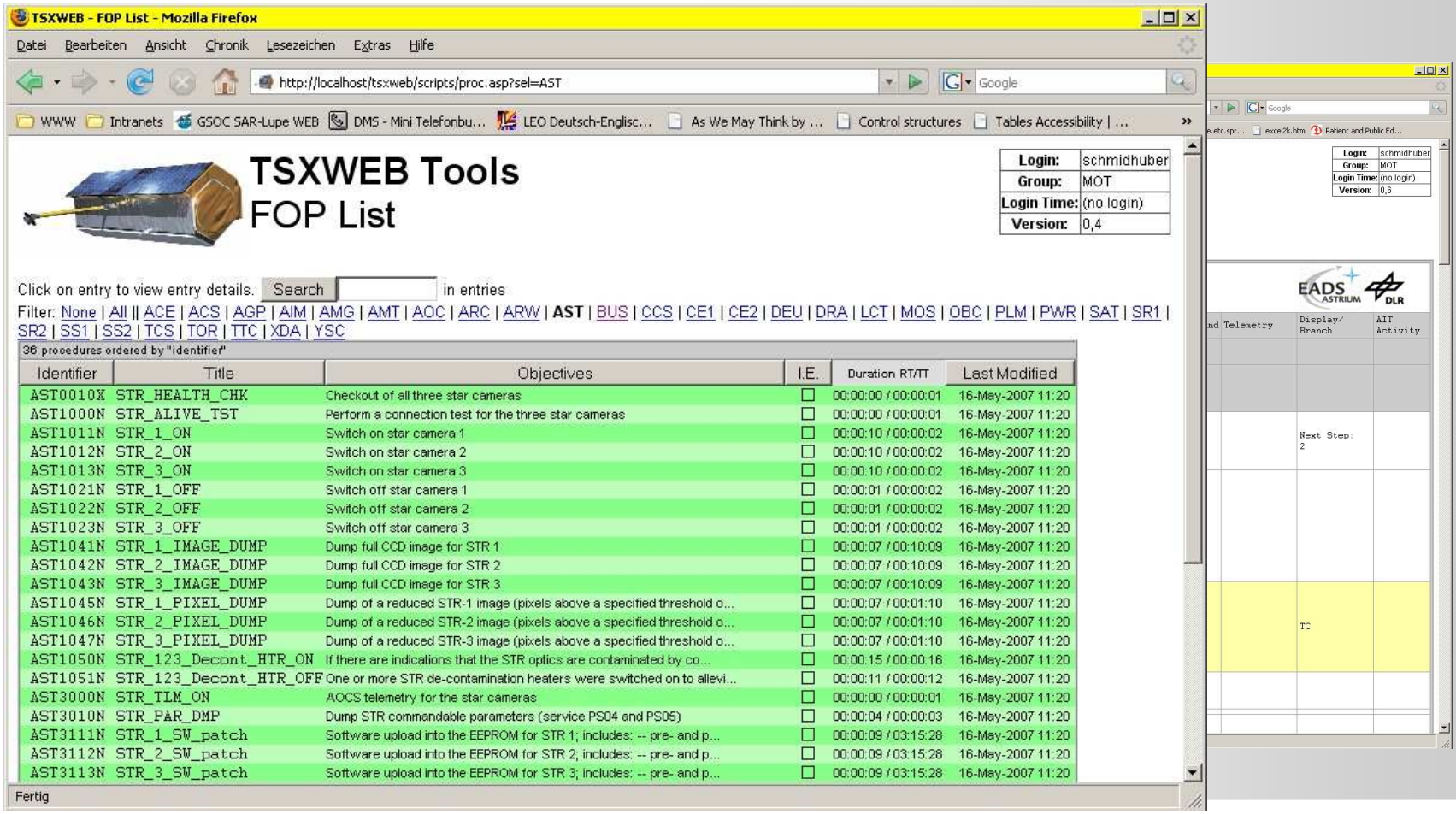
Multimission at GSOC
- OPSWEB (continued)



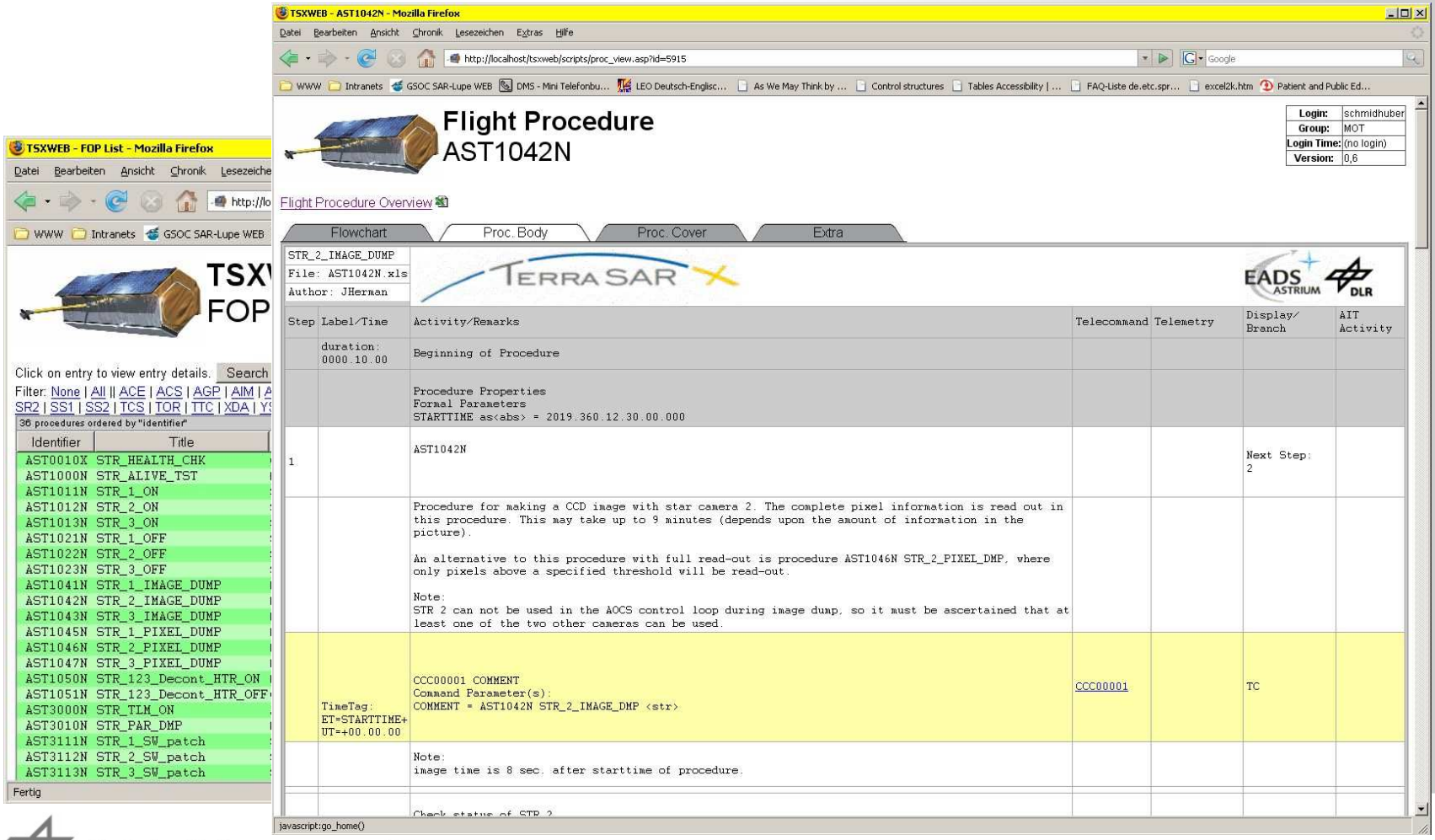
Multimission at GSOC
- OPSWEB (continued 2)



Multimission at GSOC
- OPSWEB (continued 3)



Multimission at GSOC
- OPSWEB (continued 4)



Multimission at GSOC
- Restrictions

- In some cases contractual obligations suggest or mandate the use of other components
  - E.g. use of M&C system already qualified and used for the spacecraft bus assembly and checkout
  - In the long run (5 years of routine operations plus possible extensions) even the configuration of the GSOC generic system components leads to a more cost-efficient scenario

Multimission at GSOC
- Summary

- Since 2000 GSOC successfully operated four spacecraft in a multimission environment
- The system will be augmented by up to four new missions until 2010
- Operating satellites in multimission significantly reduced the costs
- Besides cost reduction, multimission has more advantages:
  - A common team of operators ensures the know-how
  - A common environment makes working easier and more transparent
  - A common system enforces setting-up and keeping house-standards
- Even if not every new project can be set-up completely with the generic system, they too can profit from the commonality